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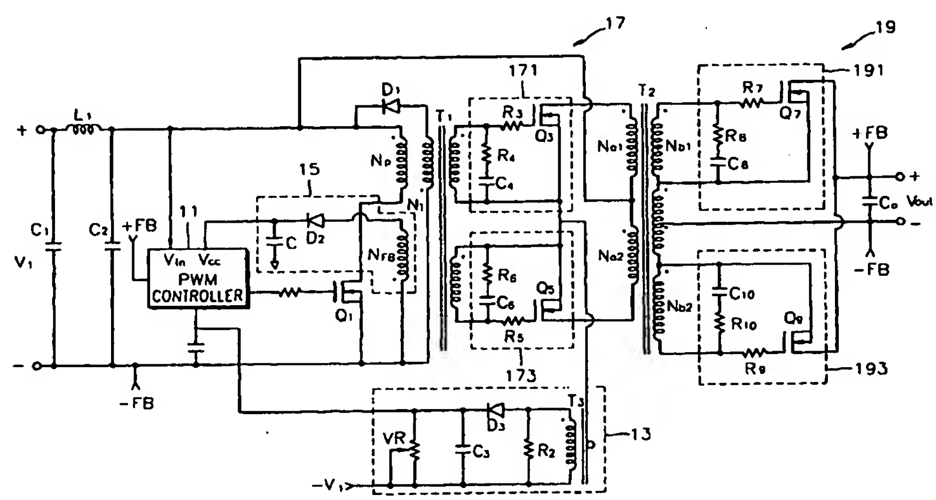
(54) Title: SWITCHING MODE POWER SUPPLY



(57) Abstract: A Switching Mode Power Supply (SMPS) which can operate at a high switching frequency is provided. The SMPS includes: a switching unit for chopping an input DC power to a square wave of the frequency and outputting the square wave; an inverter unit which includes an upper output unit and a lower output unit that are turned on/off alternately in response to a logic level of the square wave signal output by the switching unit, and generating the square wave signal; a current feedback unit for detecting the current flowing through the output terminal of the inverter unit; a switching control unit for adjusting the pulse phase of the square wave of the switching unit in response to the detection signal output by the current feedback unit and maintaining the DC voltage of a final output regular; and an output rectifying unit for rectifying the square wave signal output by the inverter unit and outputting the signal as the DC power.

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SWITCHING MODE POWER SUPPLY

Technical Field

The present invention relates to a Switching Mode Power Supply (SMPS), and more particularly, to an SMPS that can operate at a high switching frequency by preventing any oscillation within a circuit.

Background Art

A Switching Mode Power Supply (SMPS) designer has attempted to not only reduce the size of a transformer as much as possible by increasing a switching frequency (fs) but also decrease energy loss caused by coil resistance by reducing the number of coil turns. In an existing circuit configuration, if a switching frequency exceeds 100 KHz, oscillation is generated and the voltage applied across a load connected to an output terminal is attenuated. That is, original input power is not fully transmitted to the output terminal of the power supply.

Disclosure of the Invention

To solve the above-described problems, it is an object of the present invention to provide a Switching Mode Power Supply (SMPS) with high efficiency.

To achieve the above object, an SMPS according to a first embodiment of the present invention includes:

a switching unit for operating at a pre-defined frequency, chopping an input DC power to a square wave of the frequency and outputting the square wave;

an inverter unit which includes an upper output unit and a lower output unit that are turned on/off alternately in response to a logic level of the square wave signal output by the switching unit, setting the path of the current from (+) terminal of the input power to (-) terminal thereof through an output transformer and the upper output unit, or from (+) terminal of the input power to (-) terminal thereof through the output transformer and the lower output unit, and generating the square wave signal;

a current feedback unit for detecting the current flowing through the output

terminal of the inverter unit;

a switching control unit for adjusting the pulse phase of the square wave of the switching unit in response to the detection signal output by the current feedback unit and maintaining the DC voltage of a final output regular; and

an output rectifying unit for rectifying the square wave signal output by the inverter unit and outputting the signal as the DC power.

The upper output unit includes at least one module including a transistor, the drains of the transistors included in modules are commonly connected to the up terminal of the 1st coil of the output transformer, and the sources of the transistors are commonly connected to the (-) terminal of the input power.

The lower output unit includes at least one module including a transistor, the drains of the transistors included in modules are commonly connected to the down terminal of the 1st coil of the output transformer, and the sources of the transistors are commonly connected to the (-) terminal of the input power. If the transistors included in the upper output unit are turned on in response to the logic level of the input square wave signal, the current flows from the (+) terminal of the input power through the upper output unit to the (-) terminal of the input power. If the transistors included in the lower output unit are turned on, the current flows from the (+) terminal of the input power through the lower output unit to the (-) terminal of the input power. Thus, the square wave signal is generated at the output port.

To achieve the above object, an SMPS according to a second embodiment of the present invention includes:

a switching unit which is turned on/off in response to a pre-defined switching signal;

a power transformer for receiving the DC power through the 1st coil connected between the input DC power and the switching unit, chopping the DC power in response to on/off switching of the switching unit and providing the power to the 2nd coil;

a detector for sensing the current flowing through the 1st coil of the power transformer in response to on/off switching of the switching unit and feeding the current back to a controller;

the controller for generating the switching signal according to the error signal

generated as a result of comparing the output DC power signal with a reference signal, and according to the sensed signal output from the detector; and

a rectifying unit which is connected to the 2nd coil of the power transformer, and includes at least two diodes that are turned on/off depending on the logic status of the square wave signal transmitted by the inverter unit and converts AC power into DC power.

Brief Description of the Drawings

FIG. 1 is a circuit diagram showing a basic configuration of a Switching Mode Power Supply (SMPS) according to the present invention;

FIG. 2 shows a configuration of an SMPS according to another embodiment of the present invention;

FIG. 3 shows another embodiment of an output rectifying unit of the SMPS shown in FIG. 2; and

FIG. 4 is a block diagram of a PWM control circuit 11 shown in FIG. 1 according to an embodiment.

Best mode for carrying out the Invention

The present invention will now be described in detail by describing preferred embodiments thereof with reference to the accompanying drawings.

FIG. 1 is a circuit diagram showing a basic configuration of a Switching Mode Power Supply (SMPS) according to the present invention. The SMPS for low power, which receives DC power (V1) of an input rectifier (not shown) that converts AC power into DC power, can be implemented.

An input terminal which receives input power (V1) includes a pi-type (Π) filter including capacitors (C_1 and C_2) and an inductor (L_1) to remove noise of power. A transistor (Q_1) operates as a switching element that is turned on or off depending on a switching signal output by a PWM control circuit 11. The transformer (T_1) receives AC power on a 1st coil connected between the transistor (Q_1) and the input DC power (V_1) by on/off switching of the transistor (Q_1), and provides the power to a 2nd coil. The PWM control circuit 11 receives output DC power signal (+FB) and generates the switching signal (SW_{out}) by PWM-controlling depending on a difference signal

generated as a result of comparison between the +FB and a reference signal. In addition, the sensed signal (SENSE), obtained after the current change caused by the change of the output load is sensed, is fed back to the PWM control circuit 11. The PWM control circuit 11 generates the switching signal (SW_{out}) by reflecting the sensed signal.

The switching element is the transistor (Q_1), switches on/off depending on the logic level of the switching signal (SW_{out}) of the PWM control circuit 11 and switches on/off the current flowing the 1st coil (N_p) of the power transformer (T_1). The current flowing the 1st coil (N_p) of the transformer (T_1), depending on on/off of the switching transistor (Q_1), induces current into the 2nd coil and the voltage is introduced to both ends of the 2nd coil depending on the winding ratio. The square wave signal generated by the switching transistor (Q_1) is transmitted to the 2nd coil through the transformer (T_1) and input to gate terminals of two field effect transistors (Q_3, Q_5). The square waves fed to each field effect transistor (Q_3, Q_5) have different polarities. Therefore, the transistors (Q_3, Q_5) are alternatively turned on/off.

The circuit diagram shows that the 1st coil of the transformer (T_1) includes a primary coil (N_p) and an auxiliary coil (N_T). The auxiliary coil (N_T) stores energy while the switching transistor (Q_1) is off, and returns the stored energy to the output side when the transistor (Q_1) is switched on. That is, the auxiliary coil transfers the energy of the low-level signal (down part of the square wave) to the output side and thus increases the off signal level. Therefore, the auxiliary coil can provide the gate signal sufficient enough to turn the transistor (Q_5) on during the down part of the square wave. On the contrary, the primary coil (N_p) stores energy while the transistor (Q_1) is on and provides the energy to the output side to turn the transistor (Q_3) on when the transistor (Q_1) is off.

The primary coil (N_p) and the auxiliary coil (N_T) are winded to have reversed polarity. An ultra fast switching diode is used as D1, which is positioned between the primary coil (N_p) and the auxiliary coil (N_T) or between the auxiliary coil (N_T) and the (-) terminal ($-V_1$), and determines the direction of the current while the switching transistor (Q_1) is off. The thickness and the number of turns in the auxiliary coil (N_T) should be substantially the same as those of the primary coil (N_p). The output voltage signal (+FB) of the converter and the sensed voltage (SENSE) generated by

the inverter output current are fed back to the PWM control circuit 11. Then, the PWM control circuit generates the square wave pulse for on/off operation of the switching element (Q_1). The configuration of the PWM control circuit will be described in more detail with reference to FIG. 4.

A self-bias circuit 15 provides the operation power to the unit for outputting the switching signal (SW_{out}) within the PWM control circuit 11. The voltage induced by the feedback coil (N_{FB}, the pole indication (dot; mark of the start point of the coil of N_{FB}) is opposite to that of the primary coil (N_p)) of the 1st side of the power transformer (T_1) is supplied to the Vcc terminal of the PWM control circuit 11 through the diode (D_2). The capacitor (C) is used to remove ripples. The input power (V_1) is provided to the elements within the PWM control circuit 11 other than the switching output unit.

FIG. 4 shows an embodiment of the configuration of the PWM control circuit 11 shown in FIG. 1 and describes a current-mode control method. Vcc induced by the 1st feedback coil (N_{FB}) of the power transformer (T_1) provides power to an amplifier 45 that outputs the switching signal (SW_{out}). A clock generator 43, a flip-flop 44, an error amplifier 41 and a comparator 42 receive the input power (V_1) fed from a regulator 47 as operating power. The error amplifier 41 compares a voltage of the output signal (+FB) and the reference voltage (V_{ref}), and outputs an amplified error signal. The error signal is input to the comparator 42. The output current of the inverter is sensed and converted into voltage signal. Then, the sensed signal (SENSE) is input to the comparator 42. The comparator 42 compares the sensed signal depending on the peak switch current and the error signal related to the output signal, and inputs the comparison result to the RS flip-flop (latch, 44). The clock generator 43 generates the clock signal which is the square wave signal corresponding to the switching frequency (fs). The RS flip-flop 44 receives the output of the comparator 42 and the clock signal, and generates the switching signal (SW_{out}) that makes the switching element (a transistor) turn on/off depending on the logic level of the switching signal.

The main output voltage (+FB) fed back by the final output terminal is compared with the reference voltage (V_{ref}) by the error amplifier 41. The current feedback signal (SENSE) is compared with the reference voltage (1.2V) by the

comparator 42. Then, the comparison result is input to the flip-flop 44. The flip-flop 44 increases/decreases (that is to say, generating the pulse-width-modulated signal in which the duty cycle of the clock signal is modified) the phase of the clock signal generated and input by the oscillator 43 depending on the output signal of the comparator 42, to generate the switching signal (SW_{out}) and thus increases/decreases the current flowing in the transformer (T_1) depending on the change of the input voltage and the load so that the output voltage of the final output terminal can be maintained regular.

Configurations of a push-pull type inverter unit 17 and an output rectifying unit 19 which are connected to the 2^{nd} coil of the transformer (T_1) of FIG. 1 are described below. The push-pull type inverter unit 17 includes a forward-type upper output unit 171 and a forward-type lower output unit 173 which receive a square wave signal from the 1^{st} coil of the transformer (T_1). Transistors (Q_3, Q_5) are turned alternately on/off by the square wave signal whose level is changed depending on the winding ratio after receiving the square wave signal transmitted by the 1^{st} coil of the transformer (T_1). Each forward-type output unit provides the power to a load by a half cycle. The upper output unit 171 and the lower output unit 173 have the same configuration except that locations of the polarity indication of the 2^{nd} coil are reverse.

A resonance circuit is formed by the leakage inductance of the 1^{st} coil of the power transformer (T_1) for high frequency and the capacitance (C_{GS}) between the gate and the source of the transistors (Q_3, Q_5) during the turn-off. The resonance circuit causes a transient over-voltage ringing in the transient status. The ringing may have an amplitude large enough to destroy the diode or the transistor during the turn-off period. The RC element including the resistance (R) and the capacitor (C) is a snubber circuit and prevents the ringing. In addition, the RC element is connected in parallel to the 2^{nd} coil of the power transformer (T_1). The gate resistance (R) connected to the gate terminal of the transistors (Q_3, Q_5) is added to match the rising time of the square wave transmitted from the power transformer (T_1) and that of the transistor (Q_2).

As for output units 171 and 173, at least two modules can be connected in parallel as shown in the figure. That is, each output unit includes two or more modules which have the same configuration, thus minimizing power loss in the output

unit. If the number of modules increases, the power loss caused by the internal resistance of the transistors is reduced in proportion to the increased number.

Modules included in the upper output unit (171) and the lower output unit (173) have substantially the same internal configuration. However, the current is applied to the gate terminals of the transistors (Q_3) included in the upper output unit (171) in the same direction as the polarity of the 1st coil of the transformer (T_1). Meanwhile, the current is applied to the gate terminals of the transistors (Q_5) included in the lower output unit (171) in the opposite direction of the polarity of the 1st coil of the transformer (T_1). The transistors included in the upper output unit (171) and the lower output unit (173) are turned on/off alternately depending on the level of the square wave transmitted through the transformer (T_1).

The drain of the transistor (Q_3) of the upper output unit 171 is connected to the up terminal of the 1st coil of the output transistor (T_3). The source of the transistor (Q_3) is connected to that of the transistor (Q_5) of the lower output unit 173 and connected to the (-) terminal ($-V_1$) of the input power (V_1) through the 1st coil of the transformer (T_2). The drain of the transistor (Q_5) of the lower output unit 173 is connected to the down terminal of the 1st coil of the output transistor (T_3). The source of the transistor (Q_5) is connected to that of the upper output unit 171 and connected to the (-) terminal ($-V_1$) of the input power (V_1) through the 1st coil of the transformer (T_2).

The 1st coil of the output transformer (T_3) is connected with the output terminal of the inverter. As for the output terminal, the drain of the transistor (Q_3) of the upper output unit 171, (+) terminal of the input power (V_1) and the drain of the transistor (Q_5) of the lower output unit 173 form an upper terminal, a middle tab and a lower terminal respectively.

If the square wave signal is transmitted to the 2nd coil of the transformer (T_1), one of the transistor included in the upper output unit (171) and the transistor included in the lower output unit (173) is turned on depending on the logic level and the square wave is generated at the output port. The output signal is input to the output rectifying unit. That is, if the switching transistor (Q_1) connected to the PWM control circuit 11 is turned on, the transistors included in the upper output unit (171) are turned on and the transistors included in the lower output unit (173) are turned off.

Then, current flows through the (+) terminal of the high voltage power (V_1), the upper output unit (171), the 1st coil (Na_1) of the transformer (T_3) and the (-) terminal ($-V_1$) of the input power (V_1). If the switching transistor (Q_1) is turned off, the transistors included in the upper output unit (171) are turned off and the transistors included in the lower output unit (173) are turned on. Then, current flows through the (+) terminal of the input power (V_1), the lower output unit (173), the 1st coil (Na_2) of the transformer (T_3) and the (-) terminal ($-V_1$) of the input power (V_1). As described above, the square wave whose voltage level is amplified is generated at the 1st coil of the output transformer by on/off switching of the switching transistor (Q_1) and the square wave is transmitted to the 2nd coil.

The current feedback unit 13 senses the current flowing through (-) terminal ($-V_1$) of the input power (V_1) from the inverter unit 17, and feeds it back to the PWM control circuit 11. The current feedback unit 13 includes the current coupling transformer (T_2), and the polarity of the coil is shown in the figure. The resistance (R_2) converts the current induced in the 2nd coil of the transformer (T_2) into a voltage signal. Irrespective of on/off switching status of the switching transistor (Q_1), current flows through the (+) terminal of the high voltage power (V_1), the 1st coil of the transformer (T_3) and the (-) terminal ($-V_1$). Thus, forward bias is applied to the diode (D_4) and the current flows. The capacitor (C_3) is used to remove noise and the variable resistor (VR) is used to adjust the electrical potential level of the output signal (SENSE). The voltage signal (SENSE) adjusted by the variable resistor (VR) is fed back to the PWM control circuit 11.

The current feedback unit 13 senses the output current and generates the sensed signal (SENSE) that controls the switching transistor (Q_1). The transformer (T_2) electrically isolates the switching circuit unit and the inverter output unit. Therefore, oscillation and noise generated in the inverter output by the high frequency operation of the switching transistor (Q_1) can be prevented.

The output rectifying unit 19 of the switching power supply will be described. The 1st coil of the output transformer (T_3) is connected with the output terminals of the inverter 17, and the 2nd coil thereof is connected with the output rectifying unit 19. The output transformer (T_3) receives the square wave from the inverter unit 17 and reduces the signal to a certain level of voltage depending on the winding ratio. The

rectifying unit rectifies the voltage and provides DC power.

The output side of the transformer (T_3) includes the rectifying element and the capacitor for filtering. The transformer adjusts the output voltage depending on the winding ratio, and the transistors are elements for rectification and the capacitors are elements for filtering.

The output rectifying unit 19 includes the output module including the upper module 191 and the lower module 193, and the capacitor (Co) for filtering connected to both terminals of the output port.

The upper module 191 and the lower module 193 are connected to the 2^{nd} coil of the output transformer (T_3) and perform rectification. If the switching transistor (Q_1) is turned on, the transistor (Q_7) of the upper module 191 is turned on. If the switching transistor (Q_1) is turned off, the transistor (Q_9) of the lower module 193 is turned on. The output capacitor (Co) filters out small ripples and provides smooth DC power. The upper module 191 includes a snubber circuit in addition to the transistor (Q_7). The RC element including the resistance (R_8) and the capacitance (C_8) is the 1^{st} snubber circuit used to prevent transient over-voltage ringing caused by the leakage inductance of the 1^{st} coil of the transformer (T_3) and the gate capacitance of the transistor (Q_7). The RC element including the resistance (R) and the capacitor (C) is the 2^{nd} snubber circuit, which includes an RC serial circuit between the drain and the source of the transistor (Q_7), used to prevent transient over-voltage ringing caused by the leakage inductance of the 1^{st} coil of the transformer (T_3) and the capacitance (C_{oss}) between the drain and the source of the transistor (Q_7). The gate resistance (R_7) connected to the gate terminal of the transistor (Q_7) is added to match the rising time of the square wave transmitted from the power transformer (T_3) and that of the transistor (Q_7).

The lower module 193 has substantially the same internal configuration, snubber circuit and gate resistance functions and parameters as the upper module 191. However, in the upper module 191, the gate terminal of the transistor (Q_7) is connected to the coil with the polarity indication (dot) of the transformer (T_3), while in the lower module 193, the gate terminal of the transistor (Q_9) is connected to the coil without the polarity indication (dot) of the transformer (T_3). Therefore, the square wave power signal transmitted from the 1^{st} coil of the transformer (T_3) can flow by

turns depending on the logic level.

The power supply shown in FIG. 1 is useful for a relatively low input voltage, output voltage lower than input voltage, and relatively high output current, such as in a hand-phone. In addition, the power supply can provide stable power with high efficiency. That is, a battery voltage (DC 11 – 15 V) for the hand-phone or power for a vehicle is used as input voltage to obtain desired output power.

FIG. 2 shows a configuration of an SMPS according to another embodiment of the present invention. A transistor (Q_1) operates as a switching element that is turned on or off in response to the switching signal generated by a PWM control circuit 11. A transformer (T_1) receives a high frequency square wave to the 1st coil (N_p) which is connected between the input DC power (V_1) and the transistor (Q_1) in response to the on/off switching of the transistor (Q_1) and transforms it to provide the transformed power to the 2nd coil. An input current detector 23 detects the current flowing through the 1st coil of the transformer (T_1) depending on the on/off switching of the transistor (Q_1) and feeds it back to the PWM control circuit 21. The PWM control circuit 31 controls the on/off duration of a switching signal (SW_{out}) depending on an error signal generated as a result of the comparison between the reference signal and the output DC power signal +FB and a voltage level of the input current (which changes in line with the change of the input voltage V_i) detected by the input current detector 23, and controls the amount of current flowing in the 1st coil. An output rectifying unit 27 is connected to the 2nd coil of the power transformer (T_1), converts AC power to DC power and outputs one or more regular voltages.

As for the output rectifying unit 27, multiple rectifying units 271 through 274 can output multiple output voltages. In each rectifying unit, two diodes are connected to the second coil of the transformer (T1) and determine the direction of the current. That is, if the square wave signal transmitted by the transformer (T1) is (+), the diode (D11) is turned on. If the square wave signal is (-), the diode (D12) is turned on. The inductors (Lo1 through Lo4) of each rectifying unit are choke coils used to eliminate ripples of each output voltage. The auxiliary coil (NT) of the transformer (T_1) provides a magnetizing force to each coil. If the transistor (Q_1) is turned on, the current flows and magnetizes the coils. In that case, the current flows through the diodes (D_{11}, D_{21}, D_{31}, D_{41}) of the output terminal. If the transistor (Q_1) is

turned off, the energy saved in the preliminary coil (Np) is transmitted to the output terminal through the diodes (D_{12}, D_{22}, D_{32}, D_{42}). Especially, the 3rd rectifying unit 273 and the 4th rectifying unit 274 can obtain output voltage having a reverse polarity.

In the embodiment, the circuit for switching includes the PWM control circuit 31 for switching signal generation, the transistor (Q_1), the transformer (T_1) for voltage drop and the transformer (T_2) for current detection. The transistor (Q_1) is switched on/off by the square wave switching signal (SW_{out}) generated by the PWM control circuit 31. While the transistor (Q_1) is turned on, current is charged in the 1st coil of the transformer (T_1). Then, when the transistor (Q_1) is turned off, the current charged in the 1st coil is transmitted to the 2nd coil. Depending on the winding ratio of the transformer (T_1), voltage is induced to both terminals of the 2nd coil. The explanation of the operation of the above configuration is the same as that of FIG. 1.

The input current detector 23 is positioned between a source terminal of the transistor (Q_1) and the (-) terminal and feeds the signal (generated depending on the current when the transistor (Q_1) is on) back to the PWM control circuit 21. The input current detector 23 senses the current change in line with the electric potential change of the input voltage (V_1) or the input current change in line with the change of the output load, and feeds it to the PWM control circuit 21. To compensate for the current change, the PWM control circuit 21 controls the switching operation depending on the sensed signal.

The input current detector 23 detects that the current (I_{pp}) changes as the input voltage (V_1) or the output voltage (or load) changes, converts the detected current into the voltage signal and feeds it back to the PWM control circuit 21. The PWM control circuit 21 reflects the variation of the input voltage (V_1) or the output voltage and adjusts the pulse duration of the positive phase of the switching signal (SW_{out}) so that the output voltage can be maintained regular. If the current (I_{pp}) increases, the current sensing voltage detected by the input current detector 23 and fed back to the PWM control circuit 31 also increases. Then, the PWM control circuit 21 adjusts the pulse duration of the switching signal (SW_{out}) based on the current sensing voltage so that the current (I_{pp}) can be reduced.

If the transistor (Q_1) is on, current is induced in the 2nd coil by the current flowing through the 1st coil of the current-coupling transformer (T_2). A resistance

(R1) converts the current induced in the transformer (T_2) into the voltage signal. The voltage fed to a sensing terminal (SENSE) is determined based on the adjustment of the resistance value of a variable resistance (R_2). Capacitors (C_4, C_5) are used to remove ripples and noises, and a diode (D_3) is used to convert/rectify the detected square wave signal into the DC signal.

It is preferable that the ratio between the 1st coil and the 2nd coil of the transformer (T_2) is about 1:50 ~ 200. For example, in the case of an SMPS for less than 10 W, when the continuous current (I_{PDC}) flowing the 1st coil of the main transformer (T_1) is 1.0 A or less, it is preferable that the ratio between the 1st coil and the 2nd coil of the transformer (T_2) is 1: 100. In addition, preferably, the material of the core of the transformer (T_2) is the same as that of the core of the main transformer (T_1).

The PWM control circuit 21 receives the output voltage signal (+FB) of the converter and the sensed voltage signal (SENSE) generated by the input current, and generates the square wave pulse for controlling on/off switching of the transistor (Q_1). A self-bias circuit 25 provides the operation power to the unit for outputting the switching signal (SW_{out}) among the PWM control circuit 21. The current induced by an auxiliary coil (N_{FB}) of the 1st side of the power transformer (T_1) is provided to the Vcc terminal of the PWM control circuit 31 through a diode (D_2).

Especially, the power supply shown in FIG. 2 is useful for the hand-phone with a relatively low input voltage and can obtain several output voltages with different polarities. In addition, since it is possible to use electrolysis condensers for output with low capacity, an integrated circuit can be easily implemented.

FIG. 3 shows another embodiment of an output rectifying unit of the SMPS shown in FIG. 2. Except that there is no auxiliary coil (NT), the circuit connected to the 1st coil of the transformer (T_1) is the same as shown in FIG. 2. In case of the output rectifying unit 37, two diodes (D_4, D_5) with the same rating are serially connected and the resisting voltage can be increased two times. In addition, when two capacitors for output with the same rating are used, the resisting voltage is increased two times while each capacity is halved. Therefore, the circuit can operate at high switching frequency, and obtain high output voltage using low input voltage. Especially, very high voltage (about 550 V), which is applied to a lamp that

provides back light to an LCD display screen of a notebook computer, can be obtained.

Industrial Applicability

As described above, a Switching Mode Power Supply (SMPS) according to the present invention can operate at high switching frequency and obtain high efficiency. Especially, the SMPS can obtain necessary output voltage and power, using low input voltage.

What is claimed is:

1. A Switching Mode Power Supply (SMPS) comprising:

a switching unit for operating at a pre-defined frequency, chopping an input DC power to a square wave of the frequency and outputting the square wave;

an inverter unit which includes an upper output unit and a lower output unit that are turned on/off alternately in response to a logic level of the square wave signal output by the switching unit, setting the path of the current from (+) terminal of the input power to (-) terminal thereof through an output transformer and the upper output unit, or from (+) terminal of the input power to (-) terminal thereof through the output transformer and the lower output unit, and generating the square wave signal;

a current feedback unit for detecting the current flowing through the output terminal of the inverter unit;

a switching control unit for adjusting the pulse phase of the square wave of the switching unit in response to the detection signal output by the current feedback unit and maintaining the DC voltage of a final output regular; and

an output rectifying unit for rectifying the square wave signal output by the inverter unit and outputting the signal as the DC power.

2. The SMPS of claim 1, wherein the upper output unit includes at least one module including a transistor, the drains of the transistors included in modules are commonly connected to the up terminal of the 1st coil of the output transformer, and the sources of the transistors are commonly connected to the (-) terminal of the input power,

the lower output unit includes at least one module including a transistor, the drains of the transistors included in modules are commonly connected to the down terminal of the 1st coil of the output transformer, and the sources of the transistors are commonly connected to the (-) terminal of the input power, and

if the transistors included in the upper output unit are turned on in response to the logic level of the input square wave signal, the current flows from the (+) terminal of the input power through the upper output unit to the (-) terminal of the input power, and if the transistors included in the lower output unit are turned on, the current flows from the (+) terminal of the input power through the lower output unit to

the (-) terminal of the input power, and thus the square wave signal is generated at the output port.

3. The SMPS of claim 1, wherein the current feedback unit includes a current coupling transformer on the path of the current flowing towards the output terminal of the inverter unit, converts the current induced to the 2^{nd} coil of the transformer into the voltage signal, and feeds the voltage signal to the switching unit.

4. The SMPS of claim 1, wherein the output rectifying unit includes

an upper module and a lower module which are turned on/off alternately in response to the phase of the square wave signal transmitted by the inverter unit through a transformer,

wherein each of the upper module and the lower module comprises:

a transistor whose gate and source are connected to both ends of the 2^{nd} coil of the transformer and that has the drain as the output terminal; and

a snubber unit having either a 1^{st} snubber circuit connected between the gate and the source of the transistor to prevent ringing caused by leakage inductance of the transformer and gate capacitance of the transistor, or a 2^{nd} snubber circuit connected between the drain and the source of the transistor to prevent ringing caused by leakage inductance of the power transformer and capacitance between the drain and the source of the transistor.

5. The SMPS of claim 1 further comprising:

a pi-type (Π) filter including a capacitor and an inductor to remove noise of power at a port which receives the input power.

6. A Switching Mode Power Supply (SMPS) comprising:

a switching unit which is turned on/off in response to a pre-defined switching signal;

a power transformer for receiving the DC power through the 1^{st} coil connected between the input DC power and the switching unit, chopping the DC power in response to on/off switching of the switching unit and providing the power to the 2^{nd}

coil;

a detector for sensing the current flowing through the 1st coil of the power transformer in response to on/off switching of the switching unit and feeding the current back to a controller;

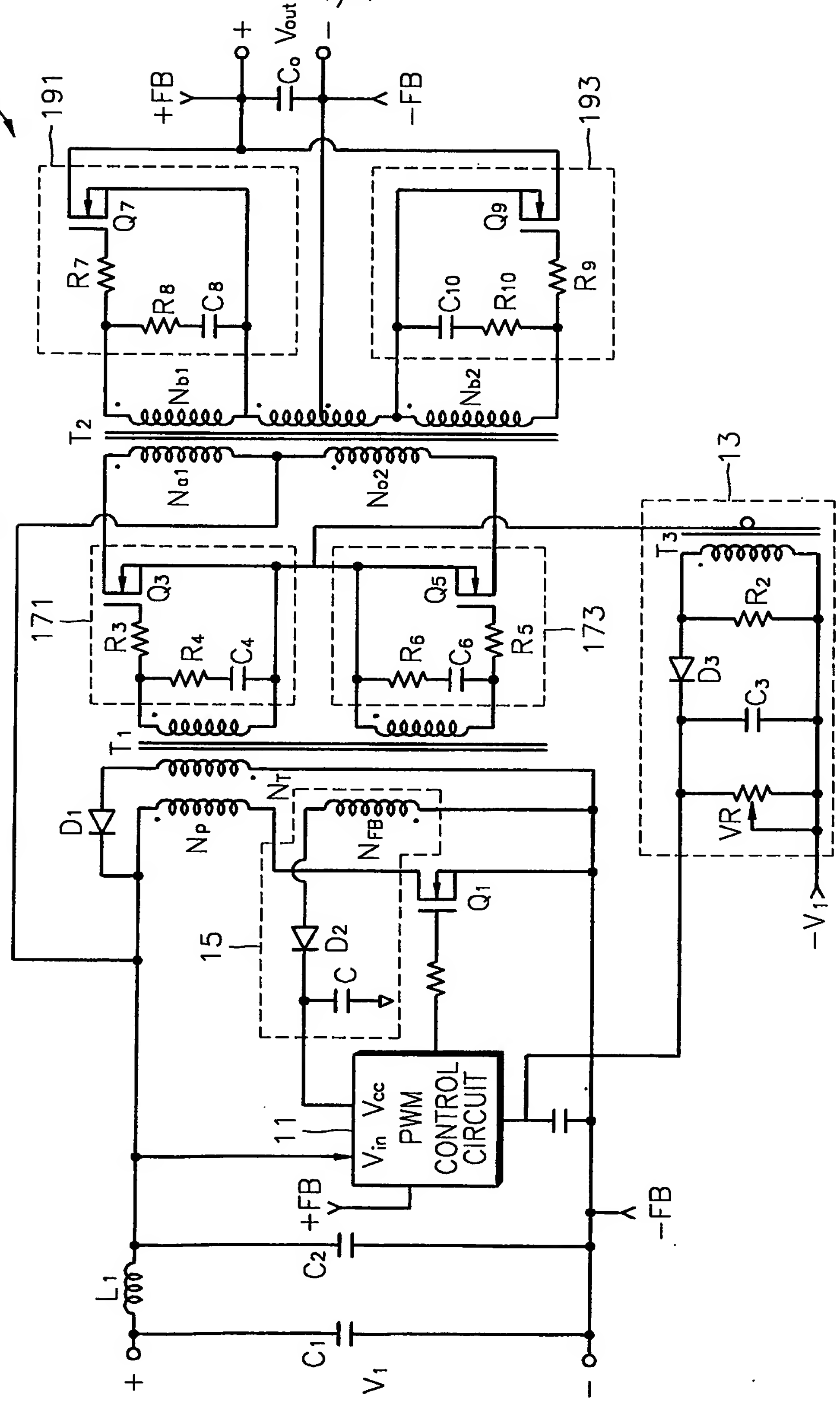
the controller for generating the switching signal according to the error signal generated as a result of comparing the output DC power signal with a reference signal, and according to the sensed signal output from the detector; and

a rectifying unit which is connected to the 2nd coil of the power transformer, and includes at least two diodes that are turned on/off depending on the logic status of the square wave signal transmitted by the inverter unit and converts AC power into DC power.

7. The SMPS of claim 6, wherein the detector comprises:

a current-coupling transformer for converting the current flowing in the 1st coil of the power transformer which is connected between (-) polarity of the input DC power and the switching unit in response to on/off switching of the switching unit at a pre-defined ratio and providing the converted power to the 2nd coil; and

a signal generator for generating the sensed signal to be input to the controller, from the current induced in the 2nd coil of the current-coupling transformer.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193
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+FB
−FB
Co
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R7
R8
C8
Q9
R9
R10
C10
Nb1
Nb2
T2
17
Na1
Na2
T3
13
171
173
Q3
R3
R4
C4
Q5
R5
R6
C6
R2
D3
C3
VR
−V1
T1
NT
D1
NP
NFB
Q1
15
D2
C
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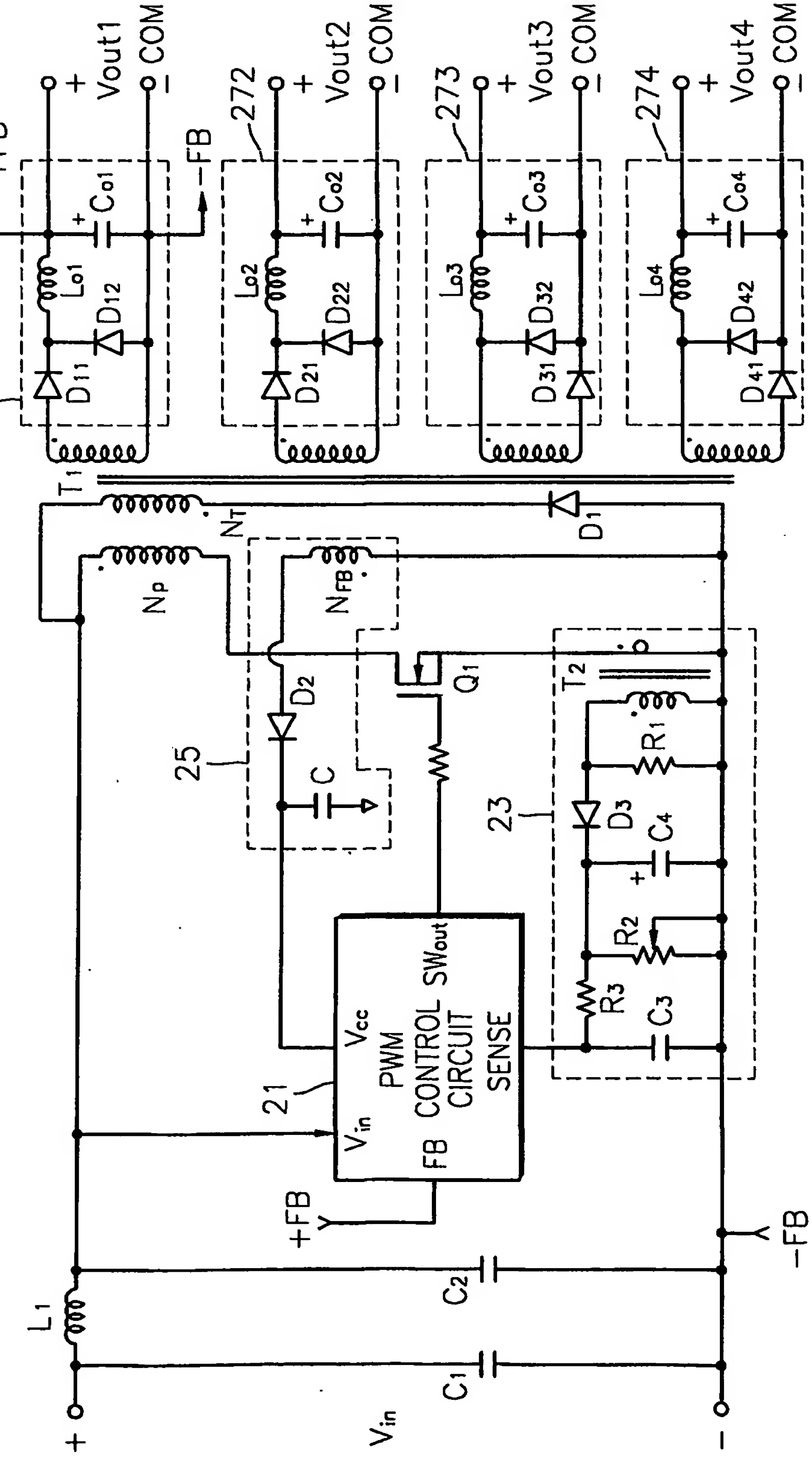
−FB
C2
L1
C1
V1
+
−

FIG. 1

FIG. 2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D2
Q1
T2
25
23
21
R1
R2
R3
C3
C4
D3
C
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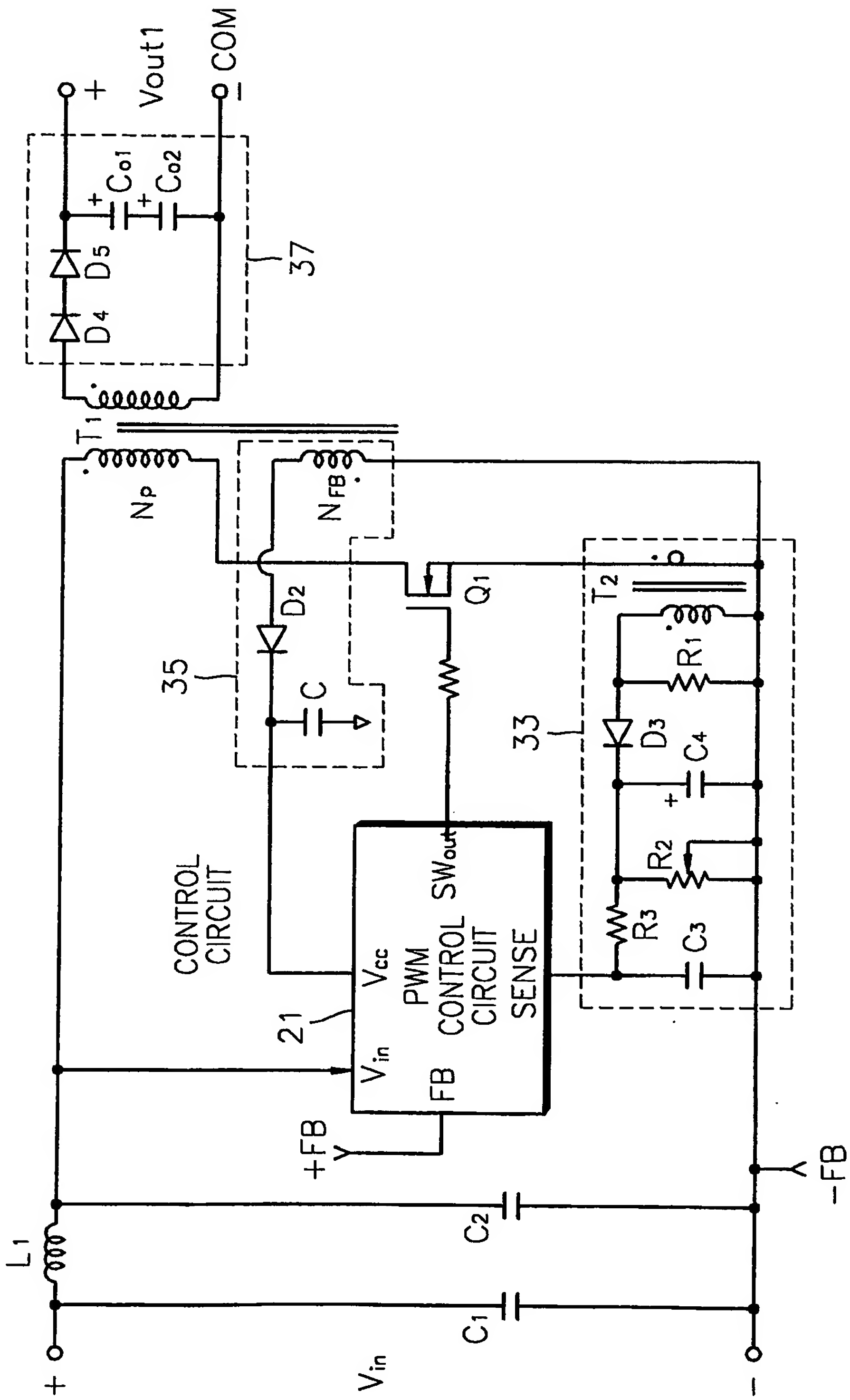
CONTROL
CIRCUIT
Vcc
Vin
FB
SWout
SENSE
L1
C1
C2
Vin

FIG. 3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N_{FB}
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Q_1
T_2
R_1
D_3
C_4
33
R_2
R_3
C_3
CONTROL CIRCUIT
V_{cc}
PWM CONTROL CIRCUIT
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-FB
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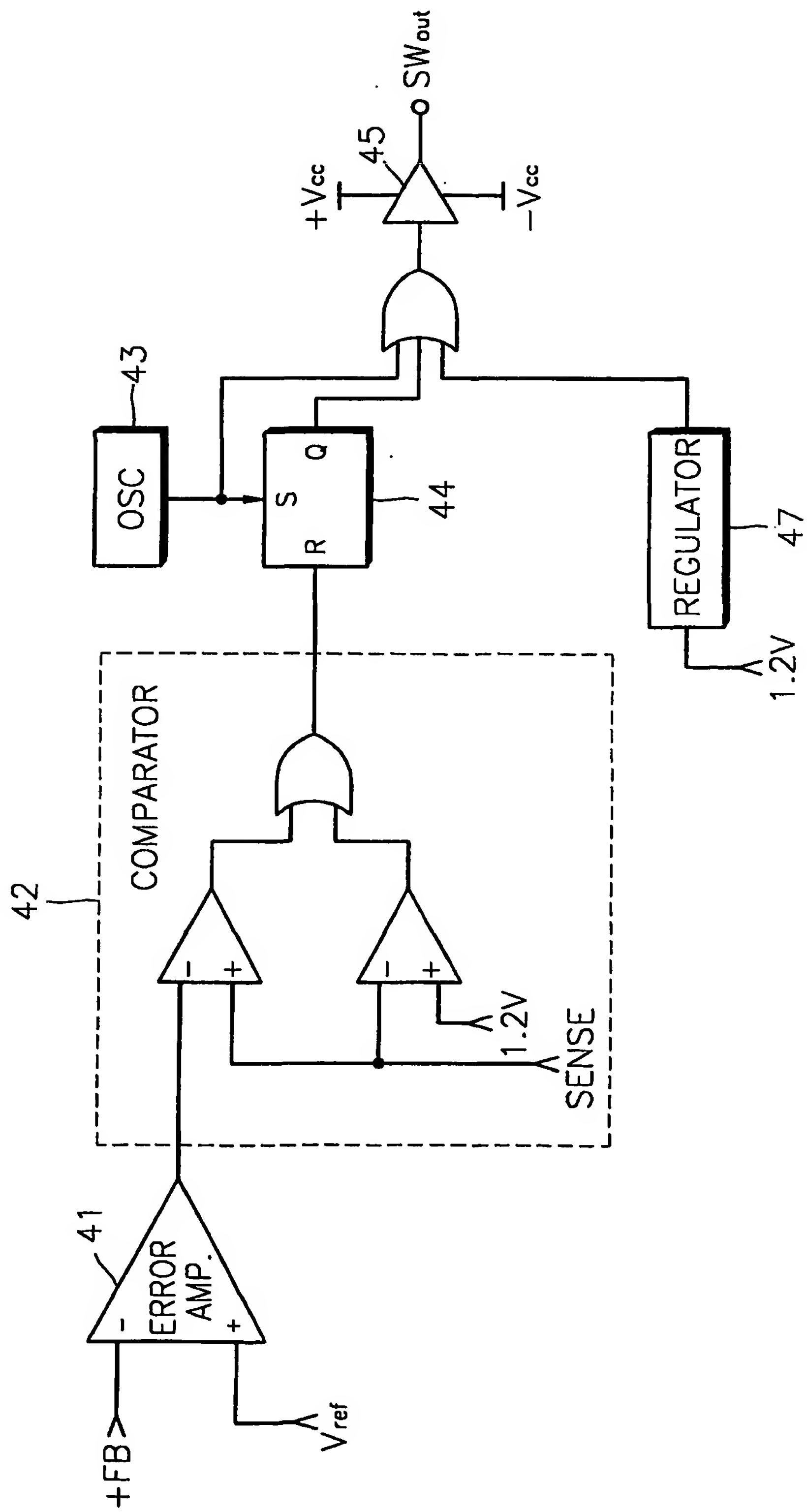
C_2
C_1
V_{in}
+
-

FIG. 4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+Vcc
−Vcc
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OSC
S
Q
R
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REGULATOR
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1.2V
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COMPARATOR
1.2V
SENSE
41
ERROR AMP.
+FB
Vref

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/01868

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H02M 3/335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

KR JP IPC above

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 09-70179 A (Toshiba Co., Ltd.) 11 March 1997 See the whole Configures and document.	1, 6
A	JP 10-63352 A (Ricoh Co., Ltd.) 06 March 1998 See the whole Configures and document.	1, 6
A	US 5351177 A (RCA Tomson Corp.) 27 Sep. 1994 See the whole Configure(1, 4) and document.	1, 6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 FEBRUARY 2002 (19.02.2002)	20 FEBRUARY 2002 (20.02.2002)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR01/01868

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 09-70179 A	11-03-97	None	
JP 10-63352 A	06-03-98	None	
US 5351177	27-09-94	GB 9219663.3 GB 9226381.3	17-09-92 18-12-92